Chapter 13
Transportation Systems

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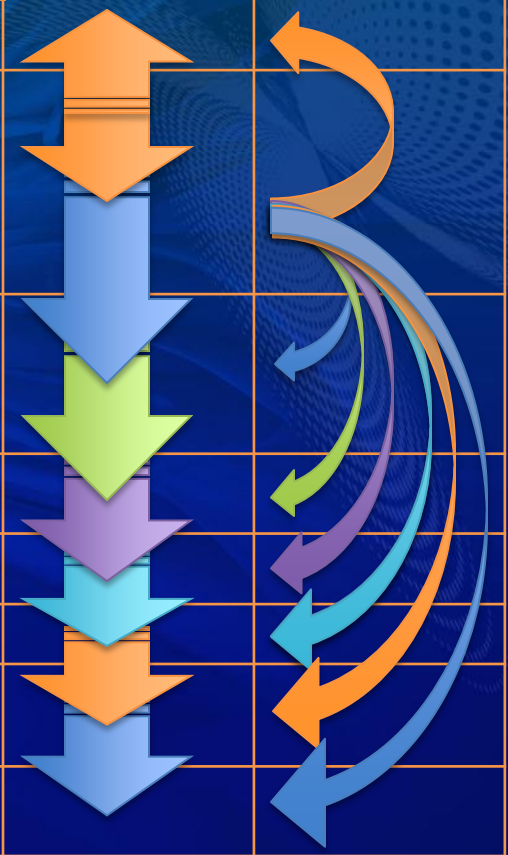
13.1 Introduction

- The transportation sector is critical to the societal needs of the community, the community built environment, and community disaster response and disaster recovery
- The other sectors interdependent with the transportation sector are: energy, communications and information, building/facilities, and water/wastewater
- The transportation sector is very complex with multiple stakeholders and interconnecting modes: roadway networks, rail lines, airports, harbors, ports, waterways and pipelines
- It is vital to community evacuation, emergency response, access to critical community facilities and recovery from disasters
- Movement of people and goods usually relies on multiple modes
- The vulnerability of the transportation sector will directly affect the resilience of the community and its infrastructure

13.1 Introduction

Societal Needs and System Performance Goals (Daily)

Social Institution	Purpose of Buildings within each Social Institution	Transportation	
		People	Goods
Family	Place to Live		
Economic	Places to work, manufacture, process, store and sell wholesale goods, serve or dine on food, entertain or be entertained, sell or buy retail goods, teach, bank, be groomed, receive or deliver goods, wait for, board, transfer or arrive on transportation system.		
Government	Place to work and public to meet in serving community including routine services, public safety and emergency services		
Health	Place for emergency; short- and long-term health needs		
Education	Place to learn		
CSO	Place to shelter and provide sustenance		
Religious Org	Place to worship and congregate		
Media	Provide a place to receive and disseminate news and information		



13.1 Introduction

Societal Needs and System Performance Goals (Critical)

Social Institution	Purpose of Buildings within each Social Institution	Transportation	
		People	Goods
Family	Place to Live		
Economic	Places to work, manufacture, process, store and sell wholesale goods, serve or dine on food, entertain or be entertained, sell or buy retail goods, teach, bank, be groomed, receive or deliver goods, wait for, board, transfer or arrive on transportation system.		
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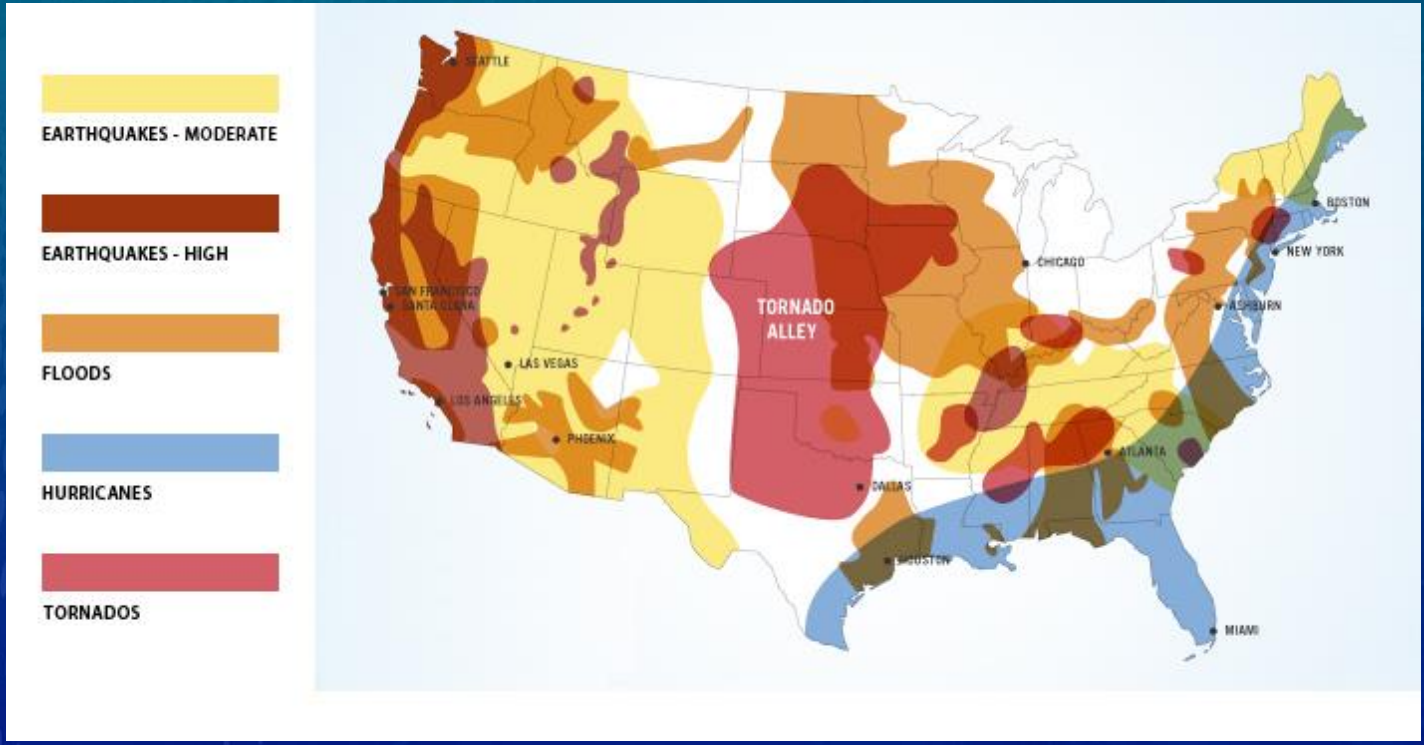
13.2 Transportation Infrastructure



- How vulnerable is transportation to the expected type of disaster?
- What recovery period was experienced in the past?
- What improvement would the community like to see?

Roads, Bridges, Highways, and Road Tunnels	Rail	Air	Ports, Harbors and Waterways	Pipelines

13.3 Performance Goals

Example: New Orleans, LA Community, Hurricane Katrina (August 29, 2005)

Infrastructure	Issue	Closed on	Closed until	Weeks Closed
Highways				
Twin Span Bridge EB	Heavy Damage	8/29/05	10/14/05	
Twin Span Bridge WB	Heavy Damage	8/29/05	1/6/06	
Lake Pont. Causeway NB	Undamaged	8/29/05	Not Closed	
Lake Pont. Causeway SB	Damaged	8/29/05	9/24/05	
Rail Corridors				
CSX Gulf Coast	Heavy Damage	8/29/05	1/31/06	
Norfolk So. Lake P. Bridge	Washed Out	8/27/05	9/12/05	
Pipelines				
LA Offshore Oil Port	Minor Damage	8/28/05	9/2/05	
Ports				
Port of New Orleans	Signif. Damage	8/28/05	9/12/05	
Port of South Louisiana	Damaged	8/28/05	8/29/05	
Air				
Louis Armstrong Int'l.	Heavy Damage	8/28/05	9/13/05	
Lakefront Airport	Heavy Damage	8/28/05	10/19/05	

Extracted from TRB Report 290 *Potential Impacts of CLIMATE CHANGE on U.S. Transportation*, 2008

13.3 Performance Goals

Set by Panel of Key Stakeholders within the Community

Transportation Panel

- Example given was for Katrina, which represented the Extreme Hazard Level to the New Orleans, LA community
- Hazard levels of *Routine, Design* and *Extreme* should be considered
- First look at systems serving the community that are critical for disaster ingress, egress and community resilience of critical facilities
- Then look at systems serving the societal needs of the community in daily life to determine the desired restoration level for community recovery

Disturbance [1]	
Hazard Type	Any
Hazard Level	Routine, Design, Extreme
Affected Area	Localized, Community, Regional
Disruption Level	Usual, Moderate, Severe

Restoration Levels [2,3]	
30%	Function Restored
60%	Function Restored
90%	Function Restored
X	Anticipated Performance

13.3 Performance Goals

To Be Filled Out by the Community and Key Stakeholders

Transportation Infrastructure	Support Needed[4]	Design Hazard Performance								
		Phase 1 Short-Term			Phase 2 Intermediate			Phase 3 Long-Term		
		Days			Weeks			Months		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Ingress (goods, services, disaster relief)										
Local Roads, Bridges and Tunnels										
State Highways, Bridges and Tunnels										
Egress (emergency egress, evacuation, etc)										
Local Roads, Bridges and Tunnels										
State Highways, Bridges and Tunnels										
National Highways, Bridges and Tunnels										
Regional Airport										
National/Int'l Airport										
Military Airports										
Subway Station										
Ferry Terminal										
Rail Stations										
Community Recovery										
Critical Facilities										
Hospitals										
Police and Fire Stations										
Emergency Operational Centers										
Emergency Housing										
Residences										
Emergency Responder Housing										
Public Shelters										
Housing/Neighborhoods										
Essential City Service Facilities										
Schools										
Medical Provider Offices										
Retail										
Community Recovery										
Residences										
Neighborhood retail										
Offices and work places										
Non-emergency City Services										
All businesses										

List transportation infrastructure and fill in goals for ingress and egress

List clusters and fill in goals for transportation infrastructure serving those clusters

13.4 Regulatory Environment

Transportation Oversight Agencies

FHWA	FTA	FRA
Roads, Bridges, Highways, and Road Tunnels	Rail Transit, Bus & Light Rail Transit	Freight and Passenger Rail

FAA	USACE USCG	PHMSA & FERC
Air Travel	Waterways, Inland ports & harbors	Natural Gas, Oil & Hazardous Liquids Pipelines

TSA	FEMA	EPA
Security Oversight	Emergency Response & Recovery	Human Health and Environment

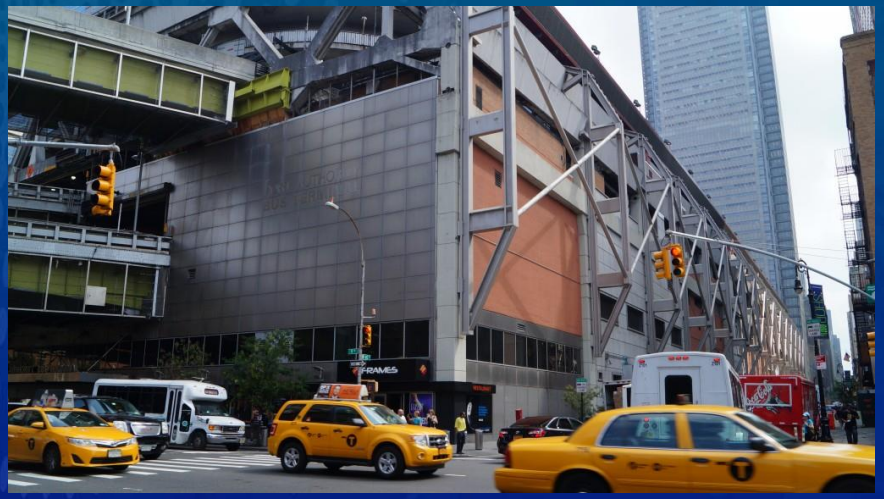
13.5 Standards and Codes

Standard and Code Agencies

AASHTO	APTA & AREMA	AREMA
Roads, Bridges, Highways, and Road Tunnels	Rail Transit, Bus & Light Rail Transit	Freight and Passenger Rail

FAA Advisory Circulars	USACE, ASCE, PIANC, AASHTO & Others	PHMSA
Air Travel	Waterways, Inland ports & harbors	Natural Gas, Oil & Hazardous Liquids Pipelines

13.6 Strategies for Implementing Plans for Community Resilience



42nd Street Port Authority Bus Terminal in NYC Seismic Retrofit with Structural Exoskeleton

The MTA in NYC is testing inflatable tunnel plugs. Hurricane Sandy flooded seven of the subway tunnels that run beneath the East River.